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Primary Examiner
Art Unit 3737

Applicant: Ekapot Bhunachet, M.D., PhD
Applicant No. 09/936,872
Title: "FLUORESCENCE ELECTRONIC ENDOSCOPIC SYSTEM"
U.S. Filing Date: September 17, 2001

Dear Examiner

Today, I have mailed the Reply to the final action to

Mail Stop Reissue
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313 -1450
USA

together with 5 references. They should reach your office within one week. To be sure that the reply reaches your office, I am faxing 6 pages of the reply. In addition, 5 pages of reference 1 are also faxed (totally 12 pages including this page). Reference 1 indicates the decision over an objection against my Japanese patent on "fluorescence electronic endoscopic system". In this objection, the demurrant raised up the invention of MacAulay et al. together with other 5 ones including those in which a black and white CCD was used, and insisted that it is easy for an expert in the field to develop the same invention as mine. However, the referees have finally decided that my patent is maintained.

Respectfully submitted
Ekapot Bhunachet
Ekapot Bhunachet

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Reply to the final action

I, the applicant, consider that the Examiner has improperly made the action final and the claim rejections are not correct based on the following reasons:

1. The invention of MacAulay had been discussed in the international phase, Japanese national phase and an objection (reference 1: objection 2003-70284), in which an Examiner and three Referees finally gave a patent (reference 2: Japanese Patent No. 3309276) to my invention.

2. My invention is developed based on an electronic (or video) endoscopic system with a black and white CCD sensor placed at the tip of the scope (Olympus), practically just by placing a barrier filter in front of the objective lens and a glass adjuster filter in the existing filter holder within the light source (reference 3, Methodology, page 563; and Discussion, pages 567-8, which is my paper published in GASTROINTESTINAL ENDOSCOPY by the American Society for Gastrointestinal Endoscopy). This OLYMPUS electronic endoscpic system has widely been used throughout Japan for almost twenty years. The application of this endoscopic system for Japanese patent was done in 1986 by OLUMPUS. Thus, my invention can turn thousand of electronic endoscpic systems commonly used only for routine endoscopic examination to very excellent fluorescence electronic endoscopic systems

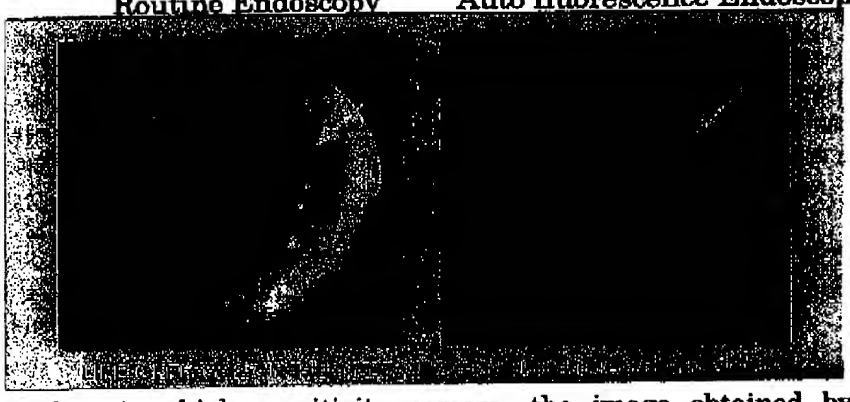
with the cheapest cost.

As the American Examiner, the Japanese Examiner and Referees firstly rejected my invention with the same reason that, having the knowledge of MacAulay's invention, it would be easy for experts in the field of endoscopy to place a barrier filter in front of the black and white CCD to develop what I claim as my invention. But, the facts show that this is not true. Reference 4 indicates Xillix LIFE-Lung Fluorescence Endoscopy system developed by OLYMPUS and Xillix Technologies Corp. based on the invention of MacAulay et al.. This commercially available system uses a combination of fiberscopes and high sensitivity camera. Note the big camera box attached to the camera suspension system. Compared to an electronic endoscopic system with a CCD sensor at the tip of the scope, this Xillix LIFE-Lung Fluorescence Endoscopy system is, therefore, difficult to operate. Since, special instruments are required, the price is also expensive. As being shown later, my fluorescence electronic endoscopic system can give brighter and clearer auto-fluorescence image than Xillix LIFE Fluorescence Endoscopy system. Provided that it was easy for endoscopic technicians of OLYMPUS to develop what I claim as my invention, OLUPUS would never have developed such an expensive and difficult to operate Fluorescence Endoscopy system. It is, therefore, obvious that my invention was not obvious to one skilled in the art, having the knowledge taught by MacAulay et al., and Longacre et al..

Before I succeeded in developing a fluorescent electronic endoscopic system, fluorescence endoscopy systems available commercially have 2 problems (reference 5, a topic published in a newspaper for medical doctor in August 24, 2000). The images obtained are not satisfactorily good and the prices are expensive. Moreover, as described above, they are difficult to operate because they use a combination of fiberscope and high sensitivity camera. Note that, at the time when this newspaper was published, electronic endoscopic systems with a black and white CCD have been widely used for ten more years; and, it was more than 6 years since MacAulay et al. filed their application to the U.S. Patent and Trademark Office.

Here is an example of auto-fluorescent image by LIFE-GI (gastrointestinal) Fluorescence Endoscopy system (OLYMPUS under Xillix's license).

Routine Endoscopy Auto-fluorescence Endoscopy



Although using high sensitivity camera, the image obtained by LIFE-GI (gastrointestinal) Fluorescence Endoscopy system (OLYMPUS) is still dim and unclear, compared to the auto-fluorescence image by my system showed below. This is because the image of LIFE Fluorescence Endoscopy system is composed of 2 colors (red, and green which is electrically changed to blue), while the image of my system is composed of 3 colors (red, green and blue).

Routine Endoscopy

Auto-fluorescence Endoscopy

Fluorescence Endoscopy by Fluorescein Sodium

Note that the lesion with a remarkably obscure outline under routine white light endoscopy can be (arrowhead) observed as a dark area with the horse-shoe-shaped contour against a bright white yellow normal mucosa under auto-fluorescence endoscopy; and as an area with week fluorescence aginst a bright blue white normal mucosa with strong fluorescence under fluorescence endoscopy by fluorescein sodium (for more details see Ref. 3).

3. There are some substantial differences between the invention of MacAulay et al. and mine.

In the invention of MacAulay et al., they use color CCD sensors or cameras. And, green fluorescence is always captured by green channel of color CCD as green fluorescent image, which is then integrated with the background image provided by red and/or blue remittance lights. In their first (Fig. 2) and third (Fig. 4) embodiments, a fiberscope is connected outside the patient's body with 2 CCD cameras, together with 2 dichroic mirrors. In their second embodiment, a fiberscope is connected outside the patient's body with a CCD camera, together with a turnable arrangement to rotate filters. Though, it is possible to integrate the fluorescence image captured by green channel with the image provided by red and blue remittance lights captured by red and blue channels by their second and third embodiments, it is practically impossible to put all these structures into the tip of an endoscope. In their fourth embodiment in which the barrier filter is placed in front a color CCD in the endosocope tip (US5,827,190 column 9 line 61 to column 10 line 44), the obtained image is composed with only two colors, because, the excitation blue light is completely cut off by the barrier filter. And, it is technically impossible to rotate the barrier filter, as described in their second embodiment, in such a limited space (usually a few mm in diameter) for a CCD sensor in the endoscope tip. Therefore, based on the knowledge taught by MacAulay et al., it is not possible to develop a fluorescence electronic (video) endoscopy system that can provide the image composing with 3 colors. And, they did not teach how to separate fluorescent image from the excitation light without using any filters or dichroic mirrors.

In my fluorescent electronic endoscopic system, using a black and white CCD sensor with a barrier filter permanently placed in front, the green or yellow or red fluorescent provoked by blue excitation light is captured by one channel (for examble, blue channel), which is then integrated with the background image captured by green and red light through the other 2 channels (for example, green and red channels). It is noteworthy that it is very easy to capture the fluorescence image by red or green channel, instead of blue, to be integrated with the background image captured by blue and green, or blue and red channels; just by connecting the blue

cable terminal to the red or green input plug, green terminal to blue or red plug, and red terminal to blue or green plug of the monitor. In case a color CCD sensor is used without the barrier filter, the yellow fluorescence is captured by red channel as red fluorescent image, which is then integrated with the background image captured through green and blue channels. It should be emphasized that in my invention only one black and white, or one color CCD sensor is needed; the fluorescence remitted from the tissue is captured as fluorescent image with different color from the original one and the background image can be provided by the remittance light with the same color as the fluorescence desired. And my invention teaches also for the first time the method to separate fluorescent image from the excitation light by a color CCD without using any filters or dichroic mirrors.

That I could develop a fluorescence electronic endoscopic system was a kind of mere accident. I was planning to do fluorescence endoscopy by fluorescein sodium to detect early gastric cancers not evident to routine endoscopy (reference 3), having only electronic endoscopic systems (OLYMPUS) used for routine endoscopy. I could get a thin-filmed barrier filter to be attached to the glass covering the objective lens of the endoscope with an instantaneous glue. But, it was not possible for me to obtain a glass excitation filter, passing only blue excitation light, to be put in front of the light source; therefore, instead of the excitation filter, I used a light balancing, blue, filter, passing mostly blue light and a little green and red light, just happening to be in our laboratory. It was very lucky for me to do so. Provided that I could place the excitation filter behind the wheel of the three primary blue, green and red filters, the image obtained would be only the dim fluorescence image (see reference 3, fig. 5H). And, that the CCD in the tip of the endoscope was black and white, not color, was also lucky for me. Usually, in case that a color CCD is used, there no need to rotate the wheel of primary color filters between the light source and the subject. Supposed that a color CCD was used and the light balancing, blue, filter was placed behind the rotating three primary color filters, in the phrase of primary blue filter, the color CCD with the barrier filter placed in front would received a green or red fluorescence as a green or red fluorescence image, which was then integrated with the green and red background image provided by green